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Performance of Douglas-fir Intervarietal Hybrids After 10 years of Field Testing

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ABSTRACT

After 10 years of field testing, Douglas-fir intervarietal hybrids have equaled the survival of inland parental lines, but doubled their height. Both hybrids and inland lines surpassed the survival and height of coastal parental lines. The performance of hybrid families seemed to reflect specific rather than general combining abilities, and variation within hybrid families was high.

KEYWORDS: *Pseudotsuga menziesii*, progeny tests, interprovenance hybridization

Hybridization offers the possibility of combining the growth potential of the coastal variety of Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) with the winter hardiness of the inland variety (*Pseudotsuga menziesii* var. *glauca*). Such hybrids would increase the productivity of the inland variety while maintaining adaptation to severe environments. In an assessment of this possibility, Rehfeldt (1977) analyzed traits reflecting growth potential, morphology, phenology, and freezing tolerance of 4-year-old hybrid families. For all traits, hybrids were intermediate between parental lines, but freezing tolerance was more similar to that of the inland line than to that of the coastal line.

In the present paper, the performance of intervarietal hybrids is assessed after 10 years of field testing. Whereas an earlier report (Rehfeldt 1977) concerned genetic variation in single traits, this report assesses performance, the integration of numerous traits that produce the phenotype on a given site.

METHODS

As described previously (Rehfeldt 1977), hybrids had been developed on 20 maternal trees from two inland provenances by using pollen from 25 coastal trees representing four provenances (table 1). Each parental tree also was represented in the test by seedlings derived from wind pollinations in their native stands. Seedlings were grown for 3 years (1-2) at a nursery on the Priest River Experimental Forest where September frosts heavily screened all coastal lines and some hybrid

Table 1.—Survival and height of hybrids according to parental provenance

Provenance	Crosses	Survival	Height
	No.	*Percent*	*Ft*
Paternal parent			
Valsetz, OR, 1,150 ft, Coastal Range	21	54	7.1
Lacomb, OR, 850 ft, Cascade Range	40	65	7.5
Lyons, OR, 1,600 ft, Cascade Range	10	54	7.5
Cowichan Lake, BC, 600 ft, Vancouver Island	20	56	7.6
Maternal parent			
Moscow, ID, 2,700 ft	46	52	7.4
Clarkia, ID, 3,400 ft	45	65	7.3

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families for tolerance to early autumn frosts. The survivors, representing 91 full-sib hybrid families and most parental lines, were planted in 1975 in row plots on a site at 3,400 feet elevation near Grangeville (lat. 46°, long. 116°) in northern Idaho.

Families were represented by one to four row plots with five to 10 seedlings within each plot. Plots were arranged at random within the plantation. There were 10 feet between rows and a minimum of 3 feet between seedlings within plots. Because of the mortality at the nursery, additional seedlings were grown in containers and were added to the plantation in 1976 as 1-year-old trees. Of the 3,900 trees planted, 25 percent were planted as 1-0 stock.

Thus, the planting contained an unequal number of crosses per parent, an unequal number of plots per cross, an unequal number of seedlings per plot, and an unequal age of planting stock. These imbalances preclude statistical analyses. Mean survival and height, recorded in 1984 after 10 years of field testing, are compared without regard to statistical probabilities.

RESULTS AND DISCUSSION

Of the planted trees, 55 percent were alive after 10 years of field testing. Survival of trees planted as 1-2 stock in 1975 averaged 59 percent while those planted as 1-0 stock in 1976 averaged 44 percent. Survival of hybrids averaged 58 percent, and for wind-pollinated inland parental lines, 63 percent. But survival for wind-pollinated coastal parental lines averaged only 20 percent.

The average tree was 5.7 feet tall. Trees planted in 1975 were about 2 feet taller than those planted in 1976. Hybrids averaged 7.3 feet, interior trees 4.2 feet, and coastal trees 3.4 feet. Standard deviations within plots averaged 2.5, 1.5, and 1.1 feet for hybrids, interior parental lines, and coastal parental lines, respectively.

The performance of individual hybrid families varied considerably (table 2). Survival ranged from 34 to 80 percent. Mean height ranged from 4.6 to 11 feet. The variation within families was also considerable. Standard deviations (table 2) indicate that two-thirds of the trees representing each family were within only 1.5 to 3 feet of the mean. In fact, the tallest tree (17 feet) came from a family in which 25 percent of the trees were shorter than 4 feet.

When the performance of hybrid families is summarized according to parental provenance (table 1), differences between means are small. It seems, therefore, that the provenance of the parent did not contribute to differential performance of hybrid families.

Indeed, the performance of a hybrid family depended on which specific trees were used as parents. No maternal tree from the interior produced hybrids of uniformly high levels of performance in several crosses. Likewise, no coastal tree produced uniformly superior hybrids. But hybrid families differed greatly and were highly variable (table 2).

Thus, after 10 years of field testing, hybrids equaled the survival of interior parental lines but were nearly twice as tall. However, the performance of a hybrid family could not be predicted from either the parental provenance or the specific parental tree. In addition, variance within families was high.

These results illustrate a high potential for hybridization to increase the productivity of inland Douglas-fir. Tree improvement, however, must proceed while maintaining adaptation to contemporary environments (Rehfeldt 1983). An expedient and safe means of utilizing hybridization in Douglas-fir breeding would involve selecting superior hybrid trees without regard to parentage, and then backcrossing these selected trees to a large number of interior trees. Superior individuals from families of stable performance should be suitable for producing clonal material for reforestation.

REFERENCES

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Table 2.—Performance of full-sib hybrid families that represent the range of responses

Parental provenance		Total trees planted	Trees planted in 1975	Survival	Height	
Paternal	Maternal				Mean	Standard deviation
				Percent	----- *Feet* -----	
Cowichan Lake	Clarkia	35	35	45	4.6	2.4
Valsetz	Moscow	40	40	67	6.1	2.2
Lacomb	Moscow	41	37	89	7.1	2.6
Cowichan Lake	Clarkia	25	25	59	8.2	2.7
Lyons	Clarkia	32	32	34	8.8	2.0
Valsetz	Moscow	40	40	80	9.2	3.5
Lacomb	Moscow	42	36	53	10.0	2.7
Lacomb	Clarkia	15	15	53	11.1	1.7